AN OVERVIEW OF EASTERN TROPICAL PACIFIC ECOSYSTEM STUDIES WITHIN THE CONTEXT OF INTERNATIONAL DOLPHIN CONSERVATION PROGRAM ACT RESEARCH

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BACKGROUND

The eastern tropical Pacific (ETP) supports one of the world's largest fisheries for yellowfin tuna (*Thunnus albacares*) with between 100,000 and 300,000 metric tons caught each year (IATTC 2002). The success of this fishery is due in large part to the as-yet unexplained association between yellowfin and two species of cetaceans, pantropical spotted and spinner dolphins (*Stenella attenuata* and *S. longirostris*, respectively). All three regularly associate in mixed-species schools (Perrin and Gilpatrick 1994, Perrin and Hohn 1994) which, when feeding, also attract large and speciose flocks of seabirds (Au and Pitman 1986). The high visibility of these assemblages, and the fact that tuna and dolphin remain together in non-feeding situations, has made it possible to visually detect, follow, and capture tuna schools by observing the associated dolphins and seabirds (Perrin 1969).

While the purse seine fishery that developed to exploit this association has resulted in a large tuna catch, it has also caused incidental mortality of the associated dolphins, which are captured in the purse seine net along with the target tuna. In the 1960s and early 1970s, this mortality was on the order of hundreds of thousands of dolphins per year (Wade 1995; Gosliner 1999) but through the use of modified fishing practices, recorded mortality has been reduced to a much lower level, on the order of thousands of dolphins per year since 1993 (Gosliner 1999). Determining the status of these affected dolphins has been an ongoing research priority for the National Marine Fisheries Service (NMFS) since the mid-1970s. The most recent related mandate came from Congress in 1997, when the Secretary of Commerce was directed to determine whether the chase and encirclement of dolphins by tuna purse seine operations was having a significant adverse effect on any depleted dolphin stock. This mandate comprised the International Dolphin Conservation Program Act (IDCPA) and resulting research forms the basis for the papers included here.

A major objective of the IDCPA research is to estimate abundance and population trends of the affected dolphins ("target stocks"). These estimates will be used to determine whether there is evidence of population recovery since the time recorded incidental mortality has dropped to low levels. Should the abundance assessments indicate a less-than-expected population growth (*i.e.* a lack of recovery), ecosystem studies will be used to investigate attribution. Specifically, a lack of recovery could be attributable to one of at least three general categories of factors: 1) fishery effects, 2) ecosystem effects, or 3) a combination of the two. Ecosystem studies can provide valuable insight into this issue. By monitoring the physical and biological habitat, it is possible to look for ecosystem changes over time that may bear on this question. Within the IDCPA framework therefore, the primary justification for ecosystem studies has been to establish a context which can be used to better interpret results of the dolphin abundance assessments. A lack of recovery for these dolphins that is not congruent with some other change in the ecosystem would provide support for the hypothesis of fishery effects as the most likely cause.

Therefore, the goal of the ecosystem studies presented here is to investigate patterns over time. The question of recovery of target dolphin populations and, should abundance assessments indicate a lack of recovery, of attribution, is beyond the scope of these studies and will be addressed in other documents.

An independent scientific peer review of this work was administered by the Center for Independent Experts located at the University of Miami. Responses to reviewer's comments can be found in Appendix A.

APPROACH

The power of ecosystem studies to detect patterns over time will increase with the number of habitat variables, taxa and trophic levels studied, and with the length of time for which data are available. Scientists of the Southwest Fisheries Science Center (SWFSC) have been conducting ecosystem studies concomitant with dolphin survey cruises in the ETP for over two decades. Two focused research projects are particularly relevant within this context: the Monitoring of Porpoise Stocks (MOPS), and the *Stenella* Abundance Research (STAR) projects. Both were dedicated research vessel surveys with two primary goals: 1) to assess the distribution and abundance of dolphins affected by the purse-seine fishery; and 2) to conduct relevant ecosystem studies. Both projects were conducted from the end of July through the first week of December: MOPS each year from 1986 - 1990 and STAR each year from 1998 - 2000. Each yearly survey consisted of 120 sea days on each of two research vessels (NOAA ships *David Starr Jordan* and *McArthur*), with the exception of STAR 1998, which also included 120 sea days on a third vessel, the University of Rhode Island ship *Endeavor*.

The study area was defined to encompass the known range of the target dolphin stocks, roughly from 30°N to 20°S latitude, and from the coast of the Americas to 150°W longitude (Perrin *et al.* 1985). This area encompasses some 20 million km^2 of ocean, three major surface currents, four surface water masses, and two smaller scale and predictable oceanographic features, the Equatorial Front and the Costa Rica Dome (Figure 1).

Tracklines for these two projects were designed to systematically survey this area; the allocation of effort was more evenly distributed during MOPS, and concentrated in the area of highest density for target species (the "core area") during STAR (Figure 2). Greater detail on study design for MOPS and STAR can be found in Holt *et al.* (1987) and Gerrodette *et al.* (1998), respectively. Shipboard operations included a variety of components focused on different taxa and disciplines. Further details can be found at <<http://swfsc.ucsd.edu/mmd/star/default.htm>> and in data reports published following each year's survey (*e.g.* Moser *et al.* 2000, Kinzey *et al.* 2001, Olson *et al.* 2001, Philbrick *et al.* 2001).

The ecosystem studies include seven components, listed below. The general question to be addressed with each is the following:

Are there temporal patterns with respect to this component of the ecosystem, and if so, how are they best described?

By temporal patterns we refer to a range of patterns that may be apparent at interannual, inter-decadal, or longer time scales. These include regular oscillations, irregular perturbations, or phase-shifts. For most components, data are limited to the fifteen year period spanned by the MOPS and

STAR projects. In a few instances, data for a longer time period are available and will be included.

LIST OF ECOSYSTEM STUDIES COMPONENTS

Environmental change in the eastern tropical Pacific Ocean: I. Observation in 1986-1990 and 1998-2000. - *P. C. Fiedler and V. Philbrick*

Environmental change in the eastern tropical Pacific Ocean: II. Review of ENSO and decadal variability - *P.C. Fiedler*

Estimates of abundance of striped and common dolphins, and pilot, sperm and bryde's whales in the eastern tropical Pacific Ocean - *T. Gerrodette and J. Forcada*

Eastern tropical Pacific dolphin habitats- Interannual variability 1986-2000 - *S.B. Reilly, P.C. Fiedler, T. Gerrodette, L.T. Ballance, R.L. Pitman, J.M. Borberg and R.C. Holland*

Investigations into temporal patterns in distribution, abundance and habitat relationships within seabird communities of the eastern tropical Pacific - *L.T. Ballance, R.L. Pitman, L.B. Spear, and P.C. Fiedler*

Temporal patterns in distribution and habitat associations of prey fishes and squids - *R.L. Pitman, L.T. Ballance, and P.C. Fiedler*

Preliminary report on ichthyoplankton collected in manta (surface) net tows on marine mammal surveys in the eastern tropical Pacific: 1987-2000 - *H.G. Moser, P.E. Smith, R.L. Charter, D.A. Ambrose, W. Watson, S.R. Charter and E.M Sandknop*

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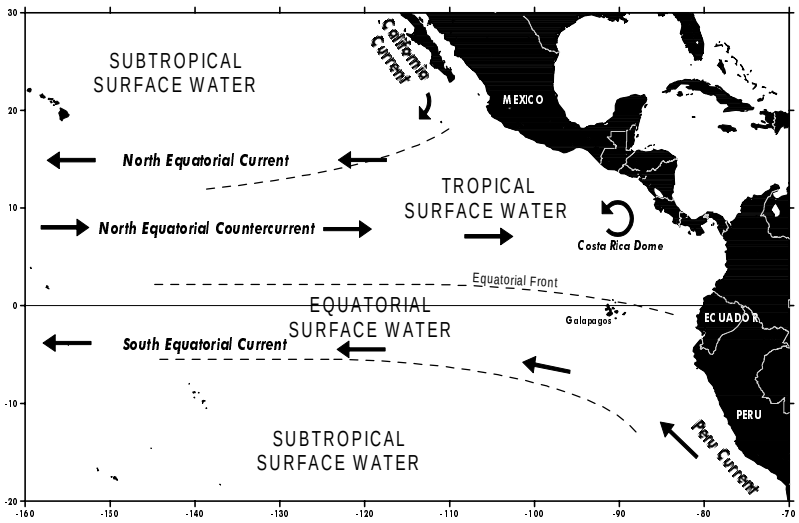

Figure 1. Schematic representation of the surface circulation and water masses of the eastern tropical Pacific.

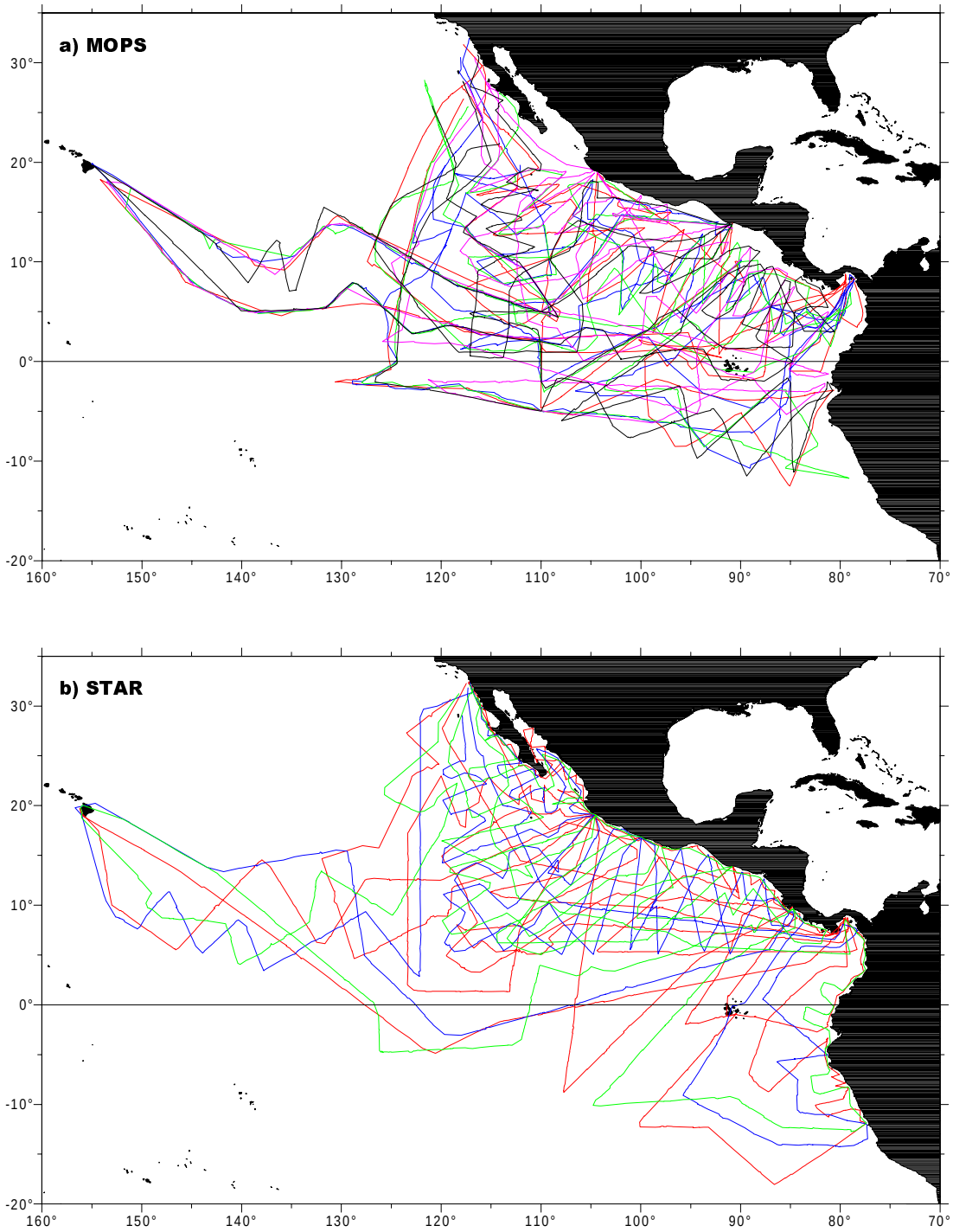

Figure 2. The study area in the eastern tropical Pacific. Lines represent ship tracks during a) Monitoring of Porpoise Stocks (MOPS) project (1986 - 1990), and b) *Stenella* Abundance Research (STAR) project (1998 - 2000). Tracks for each survey year are color-coded.

APPENDIX A

Responses to comments by reviewers from the Center for Independent Experts

Reviewers provided few comments relevant to this paper. All were helpful and all recommendations incorporated into the present version.